



Coalition to Protect Puget Sound Habitat

3110 Judson St. Gig Harbor, WA 98335
(253) 509-4987

<mailto:info@coalitiontoprotectpugetsoundhabitat.com>

*In coalition with:
Protect Our Shoreline
Henderson Bay Shoreline Association
APHETI
Case Inlet Shoreline Association
Case Beach Shoreline Association
Citizens of Harstine Island, Stretch Island
Anderson Island, Vashon Island
Jefferson County*

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The Social and Environmental Impacts of Industrial Aquaculture in Washington State

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The Social and Environmental Impacts of Industrial Aquaculture in Washington State

- **Puget Sound Ecosystem Continuous Change-Disruption, Modification**
- **Native Species Eliminated**
- **Invasive Species Used With High Ecological Impact Ratings**
- **Public's Right to Use Shorelines Restricted**
- **Consumer Health—Eating Shellfish “Nature’s Cleaning Service”**

The Issue

Sustainable small-scale family farms that began over 100 years ago on Washington shorelines are being replaced by large-scale industrial operations without state or most counties requiring environmental permits. State, counties and The Army Corp of Engineers officials have not requested independent scientific assessments, Environmental Impact Studies or cumulative impact analysis despite considerable research showing negative aquaculture impacts and associated risks to ecological health.

The Department of Ecology, The Department of Natural Resources and county governments must enforce existing laws to protect habitat and native species clearly set forth in County Codes, Critical Area Ordinances, Shoreline Management Act, the Public Trust Doctrine, and Federal laws such as the Magnuson-Stevens Act, the Endangered Species Act and the Clean Water Act.

Environmental Impacts—Taking Action on the Uplands and The Nearshore

The Puget Sound Partnership, The Puget Sound Nearshore Partnership and many other organizations agree that shoreline modifications have impaired and degraded Puget Sound ecosystems. All of these entities have clearly stated that preservation of nearshore ecosystems and the prevention of additional damage is critical. As the Department of Ecology and county officials are updating their Shoreline Master Programs significantly increasing upland regulations, unprecedented aquaculture expansion is being allowed in the tidelands, which clearly disrupts, alters, and modifies the nearshore ecosystems.

Impacts of aquaculture operations pertain to 18 of the 25 known stressors and change agents described in the Coastal Habitats in Puget Sound Research Plan (See [Section 3 a.](#) below). Industry expansion statistics, disruptive methods, and independent research documented in this report support the need for a comprehensive scientific assessment of aquaculture operations including turbidity testing and cumulative impact analysis. A regulatory framework for state and county permitting should be based on sound science prior to further expansion. It is well known that we need to change the way we care for our marine environment and all nearshore stressors and change agents including aquaculture must be evaluated to maintain the health of the Puget Sound.

Section 1: Washington State Aquaculture and Shoreline Statistics

- a. **Approximate aquaculture acreage totals** from [Army Corp of Engineers NWP48 National Marine Fisheries Service Consultation](#) page 30.

Shellfish Farm Sites	Farm Acreage	Acres of Tidelands	%
Willapa Bay	25,562	45,000	56.8%
Grays Harbor	3,995	34,460	11.5%
South Sound	4,748	27,520	17.3%
Hood Canal	1,677	unknown	
North	2,345	unknown	
Total	38,327		

Map of [Culture Areas in Puget Sound](#) (South Puget Sound, Thurston County, Mason County, North Puget Sound, Willapa Bay)

According to the Puget Sound Partnership, “Puget Sound provides an estimated 165,000 acres of shoreline for shellfish harvest, of that total the Department of Health has classified about 28,000 acres, approximately 17 %.” June 2006

- b. **Additional Aquatic Habitat Stressors:**

DNR commercial geoduck tract area is 22,575 acres. It is estimated that approximately 63 acres of subtidal habitat are disturbed annually by commercial harvesting in the various tract areas of Puget Sound.

- c. **Washington Department of Health (WDOH) Shoreline Miles Data:**

Statistics from WDOH document the dramatic increase in shoreline miles approved for commercial and recreational harvesting in Washington:

Shoreline Miles	1995	2006	% Increase
Approved for Harvest	483	826	71%
Conditionally Approved	95	37	
Restricted	43	9	
Total Harvestable Acreage	621	872	40%
Prohibited	254	247	

Industry had approximately 40% more harvestable acreage in 2006 than in 1995, despite public statements that their harvestable acreage is declining.

d. Shoreline Modification Statistic

Various government and environmental agencies (e.g. DOE, DFW, Puget Sound Partnership, Puget Sound Nearshore Partnership, People for Puget Sound, etc.) emphasize concerns of 'shoreline modification' as a major concern to environmental health, however, shoreline modifications resulting from aquaculture are not specifically addressed by officials and most environmental groups. Of the total 2,500 miles of Puget Sound shoreline, it is estimated that 33% are modified due to upland development, which is approximately **825** miles of upland modifications.

e. Industry Information

Taxes Not Paid by Industry:

1. No sales tax on exported shellfish products or shellfish sold outside of the state
2. No export tax
3. No enhanced shellfish tax (excise tax) on shellfish grown from seed by the grower
4. No Business and Occupational Tax on unprocessed shellfish, which are exported
5. Tideland acres are not assessed at their true value resulting in minimal property tax. In Mason County tideland acreage netting over \$1 million in revenue every five years is only assessed at \$200/acre, which equals only \$3 per acre per year in property taxes.

Section 2: Aquaculture Industry Methods

The following industry methods in the nearshore were taken directly from [National Marine Fisheries NWP48 Consultation](#) (pages 7-15) and put into a table by Pierce County Planning. Following is an extraction from that table of disruptive methods:

Site Preparation:

- Raking debris, cleaning the beds of algae, mussel mats and other growth, removing driftwood and predators
- Oysters--Substrate **hardened** with crushed oyster shells or gravel
- Dragging chains or net bag during low tide

Planting:

- Geoduck--Inserting 10-12" PVC pipe 4-6" diameter (Approx 40,000 per acre), PVC tubes with plastic mesh net, rubber bands, additional canopy netting
- Oysters/Clams-Reusable plastic net bags with plastic ties or galvanized metal rings (up to 2,000 bags per acre)
- Clams-- Laying down nets, bags may be placed in shallow trenches, wood, metal racks with legs
- Long lines--Inserting metal stakes or PVC pipe, nylon lines--2 ft high
- Rafts--Anchors of concrete, foam filled floats or recycled food grade containers (Totten Inlet rafts are 30 x 30)

Harvesting:

- Geoduck--extracted from substrate 3ft down by using 20 gallons per minute of seawater at approximately 40 pounds per sq inch of pressure using hose and nozzle
- Oyster--By hand or harvest bag lowered from boom crane or hydraulic winch at high tide
- Clam- By hand dig using rake or mechanical clam harvesting
- Long lines--Vessel equipped with davits & winch works along the suspended culture lines

On Going Site Maintenance

- See Site Preparation above (Page 4)
- Oysters--Harrow, a skidder with rake like tines, towed along the bottom by a boat

Placement of Geoduck Nursery Plastic Pools in the Nearshore

The Corp NWP48 review did not include the practice of placing geoduck nursery plastic pools on intertidal beaches. Taylor Shellfish and Seattle Shellfish placed numerous plastic pools on top of 4 x 8 sheets of plywood in Hammersley Inlet (Cape Horn) and on approximately one acre in Spencer Cove. Despite the documented impacts, the pools still remain in Spencer Cove. According to comments contained in the preliminary SEPA determination: "The pools have a substantial impact on marine intertidal habitat. The way to avoid impacts is to not place these structures in intertidal areas." See [comments from DOE](#)

These large scale industrial disruptions, modifications and alterations to the nearshore are not merely occasional disturbances, but perpetual with the intention of converting marine tidelands into industrial shellfish feedlots. See [photo documentation of Aquaculture](#) impacts.

Nearshore studies point out the stressors and the need for protection and restoration of this critical area. Depending on the site and the use of new technology (i.e. plastics), industry can utilize the majority of the Nearshore area (+7 to -4 tide) layering clams, oysters and geoduck. The following aquaculture research covers impacts that affect Puget Sound native species resulting from: disturbance/ alteration of the nearshore habitat and aquatic vegetation, modification of forage fish and rearing areas, removal of essential macrophytes (algae), ecological carrying capacity, accumulation of shellfish fecal deposits/organic matter in low flushing areas (like South Puget Sound), plastic pollution and the unlimited use of invasive species.

Section 3: Nearshore and Puget Sound Research/Studies

"The Nearshore environment covers the most productive waters of Puget Sound." The disruption, alteration or loss of this natural habitat and ecological functions caused by aquaculture are well documented as outlined in the following independent research:

a. [Coastal Habitat in Puget Sound: A Research Plan in Support of the Puget Sound Nearshore Partnership-- 11/06](#)

"The beautiful and productive inland marine waters and shorelines of Puget Sound in Washington are considered a National treasure." Page 1.

"Despite these population pressures, Puget Sound is still home to tremendous biological richness that includes more than 200 species of fish, 100 species of birds, 26 different marine mammals and perhaps 7,000 species of marine invertebrates, including the worlds largest octopuses and more than 70 kinds of sea stars. This biological richness is supported by an equally diverse community of primary producers, with more than 625 species of marine algae (seaweeds), 6 species of sea grasses, and hundreds of species of phytoplankton." Page 1.

"However, the real problem to be addressed is change in the ecological processes that create and maintain habitats, which in turn produce the ecosystem resources that are so highly valued (Fig 1.). Page 2.

"Because nine of the ten Puget Sound species identified as endangered or threatened rely on nearshore environments, the declines are at least in part, likely related to problems in nearshore ecosystems in Puget Sound." Page 3.

"The diversity of the species in decline in Puget Sound suggests systemic rather than isolated problems. Because many of these declining species rely on nearshore environments, the declines are at least in part, likely related to problems in the nearshore ecosystems of Puget Sound. Although some of these declines are the result of overharvesting---direct losses through poor management---these declines also can be viewed as symptoms of underlying causes; loss of habitat, degradation of water quality, and in turn, from the disruption of ecosystem processes supporting these habitats." Page 11.

Stressors

Aquaculture scores 18 out of 25 stressors or change agents as shown below based on the industry methods chart (Section 2) and independent scientific studies provided in this review. (See next page for chart of [Stressors and Change Agents](#))

Per Coastal Habitat Research
 Stressors and Change Agents
 Table 2, Page 14

Toxics	Aquaculture Stressor
1. Add toxic	YES-Spraying
2. Contribute fecal coliform bacteria	
3. Increase marine debris	YES
4. Increase air deposition	
5. Increase sediment loadings	YES
Input Changes	
6. Decrease sediment loading	
7. Alter freshwater input	YES
8. Alter runoff timing	
9. Increase strength of peak flow	
Ambient changes	
10. Alter light transmissivity from turbidity	YES
11. Cause shading (structures)	YES
12. Produce noise	YES
13. Create physical disturbance via intrusion	YES
14. Change Depth of shoreline slope	
15. Alter sediment type, including via water transport	YES
16. Physically disturb the sediments	YES
17. Re-suspend sediment	YES
18. Reduce endemic benthic habitat area	YES
19. Sea level change	
20. Add constructed habitat	YES
21. Alter seawater temperature regime	
22. Impede water circulation	YES
Biota	
23. Extinction/threatening of marine species	YES
24. Introduction of exotic marine species	YES
25. Alter local marine species composition	YES
26. Change marine organism abundance	YES

These stressors and change agents impact all but the Coastal Forests as shown below:

Valued Ecosystem Components—Coastal Habitat Research--Page 21

- Salmon
- Forage Fish
- Native Shellfish
- Eelgrass and kelp
- Coastal Forests
- Beaches and bluffs
- Orcas
- Marine and shore birds

b. State of the Nearshore Ecosystem

[Reconnaissance Assessment of the State of the Nearshore Report](#) Including Vashon and Maury Islands (WRIAs 8 and 9) by King County Dept of Natural Resources, May 2001, Figure 7--Potential Stressors in the Coastal Ecosystem of the Pacific Northwest.

Aquaculture is included in "Altered Habitat Structure" as shown in Figure 7.

Chapter 6-Food Web

"...this section describes four major parts of the food web: phytoplankton, zooplankton, benthic infauna, and secondary consumers. Because phytoplankton and zooplankton are essential components of Puget Sound food chains, this section contains information on stressors to these organisms. It also discusses links between food chains and nearshore habitats." Page 6-1.

"Benthic infauna (organisms that live in the sediments) and epifauna (organisms that live on the sediments) comprise a diverse assemblage of taxa including clams, crabs, worms, snails, shrimps, and fishes. These burrowers, scavengers, predators, and filter feeders are capable of processing vast amounts of phytoplankton, zooplankton, plant matter, sediments, detritus, and other nutrients. They play important intermediate roles in the nearshore food web, acting as converters of organic matter and making it available to higher trophic levels, which contributes to increased productivity of fish and wildlife. Page 6-7.

Currently there are no restrictions or tests on the density of shellfish feedlots allowed in Washington despite warnings from scientists regarding ecological carrying capacity. These shellfish are consuming vast quantities of phytoplankton and zooplankton also required by native species. Industry practices shown above are allowed to continually disrupt this web of life and eliminate natural organisms in the nearshore.

c. [Protecting Nearshore Habitat and Functions in Puget Sound - An Interim Guide](#), October 2007

"Because all forage fish species rely on nearshore habitats during at least some part of their life history, the protection of these habitats is critically important to the long term sustainability. In addition, because forage fish are a critical prey resource for a number of species including ESA listed salmon and marine mammals, the protection of forage fish habitat is important to these ESA species as well." Page II-17.

Figure 11.9 Forage Fish Spawning Habitats in the Nearshore Zone of Puget Sound-Page 11-17.

"Kelp and eelgrass are marine aquatic plants that thrive in the nearshore." Page II-29.

"Kelp and eelgrass play a critical role in the marine ecosystem as primary producers, generating nutrients and substrate that form the base of the food chain." Page II-30.

Page II-17 documents that the main forage fish species habitats range from +10 tide to -4 tide which coincide with shellfish aquaculture preferred areas:

- Clam Culture +7 to +3 tide,
- Oyster +3 to 0 tide,
- Geoduck +3 to -4 tide

It is well documented by scientists that the lower intertidal zone is the most productive section of the Nearshore, which is where industry is expanding geoduck feedlots.

d. [Geoduck aquaculture as perturbations to eelgrass](#), Ruesink & Rowell, Sea Grant presentation, Video.

"Eelgrass density was depressed in summer by space competition with geoducks." "When geoducks were harvested at the end of the experiment, eelgrass shoot density dropped by more than 70 percent."

e. [Marine Forage Fishes in Puget Sound](#), Dan Penttila, 2007

"Adjacent habitats are used as nursery grounds by all three (forage) fish species."
Page v.

"Standard aquaculture practices may have profound effects on the benthic ecology of Washington State's tidelands and the conservation of forage fish spawning areas, especially for herring. In many areas, herring spawning grounds are now coincident with shellfish culture areas, particularly on tide flats occupied by beds of the native eelgrass.....(WDA) has regulatory authority over aquaculture activities that occur in intertidal areas of state waters. The Washington Department of Natural Resources (WDNR) has authority over state aquatic bottomlands and marine vegetation management. These agencies together with WDFW should seek a coordinated approach to the management of the growing aquaculture industry, with an eye toward modification of habitat-damaging culture practices and the mitigation of existing habitat degradation for which the industry has been responsible." Page 16.

According to State Aquaculture Regulatory Committee March 2008 notes: Dan Penttila stated "The intrusion of nearshore/intertidal aquaculture practices into these types of sensitive habitats would be of "concern," since the industry has not paid particular attention to minimizing negative impacts in the past, in my opinion." [SARC Meeting Notes](#), March 10, 2008.

f. [Artificial Propagation of Fish and Shellfish](#) Pacific States Marine Fisheries Commission

"The artificial propagation of native and non-native fish and shellfish species in or adjacent to salmon EFH has the potential to adversely affect that habitat by altering water quality, modifying physical habitat, and creating impediments to passage." "Various methods of shellfish culture and harvest also have the potential to adversely impact salmon EFH, such as dredging in eel grass beds, off-bottom culture, raft and line culture, and the use of chemicals to control burrowing organisms detrimental to oyster culture."

g. [Puget Sound Salmon Recovery Plan](#) **South Sound Salmon Recovery Group -- Chinook & Bull Trout Recovery Approach for Puget Sound**

Aquaculture Stressor Chart--“Shellfish aquaculture in South Sound alters plant and animal assemblages and results in the loss of shallow nearshore habitat diversity important to salmon resources. These impacts may be potentially positive or negative depending on the type of aquaculture practice. We hypothesize that shellfish aquaculture reduces productivity, abundance, spatial structure, and diversity of salmon populations.” Chapter 4, p. IV-13. [The Puget Sound Salmon Recovery Plan, South Sound Watershed Profile, 2007](#)

"Cultivating shellfish in the South Sound results in the loss of shallow nearshore habitat and habitat diversity that is important to salmon." Ch 5. Pg 299.

Photos: [Aquaculture impacts ecological functions](#) by vegetation removal, elimination of starfish and diverting natural freshwater inputs by digging trenches in estuaries.

h. **Industry Altering & Changing Natural Nearshore Habitat----Artificial Reefs, 3-Dimensional Reefs, Beach Graveling and Addition of Oyster Shell, Importance of Unstructured Intertidal Areas**

[Marine and Estuarine Shoreline Modification Issues](#) White Paper April 2001

“Alterations to nearshore hydrology affect local sediment conditions, which can affect habitat structure...In addition, organic matter content can change with altered sediment grain size. Organic content provides food for small animals residing in the sediment, as well as a source for remineralized nutrients important to support growth of rooted plants. Increased turbidity levels from sediments suspended by added turbulence and scour may also affect vulnerable juvenile and filter-feeding fish.” Page 40.

“Specific studies on the impacts of beach graveling have shown that burial of existing sediments and modification of substrate size and structured complexity can lead to shifts in benthic assemblage composition (Thom et al 1994b) (Table 8). Page 44.

“Because of they substantially disrupt habitat structure, change local community structure and alter predator/prey relationships in an area, artificial reefs may pose a potential impact on salmon and other migratory fish species.” Page 51.

“In Grays Harbor estuary, addition of oyster shell material over intertidal mudflats resulted in increased habitat complexity, altered prey communities, and a shift in transitory fish species. Page 54.

US Fish and Wildlife NWP48 Consultation—Reefs, 3-Dimensional Reefs

http://www.fws.gov/westwafwo/publications/Biological_Opinions/2008_F_0461_BO.pdf

"In fact they point out that although species abundances may be greater in the SAG (submerged aquaculture gear) it is dominated by few species (DeAlteris et al. 2004, p. 873). It is clear that SAG, at least large structural gear such as rack and cage culture, provides habitat for large numbers of organisms. However, the community attracted to these structures was dominated by a few species while the SAV (eelgrass) supported a more equal distribution of organisms. Therefore, although

SAG provides similar habitat functions to SAV for some species, it may not, at least according to this study, satisfy the habitat needs of as great an assemblage of species as SAV."

"While it is apparent that oyster long-line plots provide some of the same habitat functions as eelgrass, it is unlikely that they provide the same nursery functions."

"...composition in the culture methods described above differs from that found in eelgrass beds, which provides nursery habitat and supports a diverse community of aquatic organisms. Additionally, culture methods that suspended bivalves from floats, rafts or lines, or spread them along the substrate do not provide the same habitat features as 3-dimensional shellfish reefs, which are constructed primarily for restoration and are not used to grow robust individual shellfish for market."

"Large shellfish operations growing large numbers of shellfish may cause a shift in the food web through reducing prey for primary consumers at the base of the food web. This is more likely to occur in sheltered embayments where flushing rates are low and foraging habitat for juvenile fish is limited or discontinuous. If shellfish are present at "natural" levels, their filtering activities would not upset the balance of the intertidal food web. However, aquaculture species are mostly non-native, planted at high densities, and filter larger quantities of water (phytoplankton) than the native oysters. Therefore, they may have a competitive advantage and reduce available food for other planktivores. This may be a more significant issue in confined or isolated embayments."

"Shellfish can compete directly with forage fishes through consumption of copepods and amphipods. Recent studies have shown that shellfish may also consume larger benthic and pelagic organisms (Davenport et al. 2000; Lehane and Davenport 2002"

"Dumbauld et al. (2009, p. 18) present a summary of the literature describing the role of shellfish aquaculture as structured habitat for fish and invertebrates. They point out that the majority of studies investigate the role of natural assemblages of shellfish rather than aquacultural settings. In these studies oysters and mussels form 3-dimensional reefs that moderate water flow allowing colonization of algae and invertebrates and providing refugia and food resources. In most cases however, in standard aquacultural settings, shellfish are suspended or planted directly on the substrate and not allowed to form 3-dimensional reefs. Therefore, their role (particularly nonnative species) in providing habitat should not be inferred from the studies of bivalve reefs (Dumbauld et al. 2009, p.18)." Page 121.

Georgia Straights Alliance---Artificial reefs

<http://www.georgiastrait.org/?q=node/604>

"Reefs attract sea creatures, but don't necessarily cause an increase in living matter. And there may be some environmental harm." Bill Summers, Oceanography Professor at Western Washington University

Ocean Conservancy—Artificial reefs

http://www.oceanconservancy.org/site/PageServer?pagename=issues_artificialreefs

"Although most artificial reefs offer potential habitat for certain kinds of marine life, these are not always happy homes. Artificial reefs can cause damage to natural habitats during their

construction and can displace naturally occurring species and habitats. They also tend to concentrate fish unnaturally, making them more vulnerable to over fishing. In some cases, they introduce toxins and other pollutants into the ocean."

<http://www.newsweek.com/id/142534>

"Ultimately, artificial reefs are no replacement for natural ecosystems." Jack Sobel, director of conservation science and policy at the Ocean Conservancy

Mud Matters! Structural complexity of biogenic habitats shapes the littoral ecology of mobile benthic predators-Dr. Kirstin K. Holsman, Dr. David Armstrong, Dr P. Sean McDonald

<http://www.wsg.washington.edu/research/geoduck/presentations/holsman.pdf>

"And what I want to talk about today is how unstructured littoral or intertidal habitats are important to mobile predators, especially in estuarine systems." Page 7

i. [Influence of Intertidal Aquaculture on Benthic Communities in Pacific Northwest Estuaries Scales of Disturbance](#)

"Ensuring that estuarine ecosystems are sustainable for the breadth of processes and resources require a comprehensive assessment of both natural and anthropogenic disturbance regimes, landscape influences and the effects of local management for particular species on other resources." Page 1.

j. [Tidal exchange, bivalve grazing, and patterns of primary production in Willapa Bay, Washington.](#)

Marine Ecology Progress Series 341:123-139-- #36

http://www.caseinlet.org/uploads/Environ_bibliography.doc

"Modeling study to explore causes of declining phytoplankton abundance into Willapa Bay. The model shows that, during the summer, phytoplankton declines from bay Center to Sunshine Pt (junction of Naselle R and Lon Island Slough) more than would be expected from simple mixing of rich ocean and poor river water. The extra loss is consistent with the capacity of cultured oysters to filter it out. The model indicates that adding more oysters to the bay would reduce individual growth rates—essentially the bay is near carrying capacity." [Funding: NOAA Sea Grant. NSB at UW Oceanography].

While carrying capacity is being studied to determine optimum oyster growth rates, there is no evidence that ecological carrying capacity has been studied to determine the impact on native species dependent on phytoplankton for survival.

k. [Puget Sound Partnership](#)

[Seven Categories of Threats and Drivers for Puget Sound Ecosystems](#) – Summary

Aquaculture was added to the top six threats to Puget Sound in 2008 due to impacts on habitat and biodiversity as detailed in the [Species and Biodiversity Discussion](#) paper pages 13-14 and [Habitat and Land Use](#) discussion paper page 8.

I. Southern Resident Killer Whales---Importance of Habitat and Prey in Puget Sound

[Proposed Conservation Plan for Southern Resident Killer Whales](#) –Prepared by National Marine Fisheries Service, Northwest Regional Office, August 2005

“The public should be encouraged to promote conservation plan implementation through their elected representatives at the federal, state, provincial, and local levels.” Page 117

Southern residents—“This population consists of three pods, identified as J, K, and L pods, that reside for part of the year in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the late spring, summer, and fall (Ford et al. 2000, Krahn et al. 2002).” Page 7

“Healthy killer whale populations are dependent on adequate prey levels. Reductions in prey availability may force whales to spend more time foraging and might lead to reduced reproductive rates and higher mortality rates. Human influences have had profound impacts on the abundance of many prey species in the northeastern Pacific during the past 150 years.” Page 61

“Information on the diets of resident killer whales in Washington and British Columbia is very limited, but it is generally agreed that salmon are the principal prey in spring, summer, and fall (Heimlich-Boran 1986, Felleman et al. 1991, Ford et al. 1998). Current data suggest that Chinook salmon, the region’s largest salmonid, are the most commonly targeted prey species (Ford et al. 1998, Ford et al. 2005). Other salmonids appear to be eaten less frequently, as are some non-salmonids such as rockfish, halibut, lingcod, and herring.” Page 62

“Cumulative Effects--It is not clear, and may be impossible to quantify or model, which of the threats or combination of threats the southern resident killer whale population is subject to is the most important to address relative to recovery. It is likely that there is a cumulative effect, which could be more pronounced due to the small size of the southern resident population. Disruption of foraging behavior, either from vessel traffic and sound, or reduction of preferred prey species may introduce a stressor exacerbating the immunosuppressive effects of accumulated contaminants in the blubber and other tissues of each individual killer whale. Adequate nutrition is the basis for maintaining homeostasis, but if a killer whale is unable to eat for some period of time due to anthropogenic stressors, blubber stores become mobilized leading to higher contaminant blood levels and increased negative effects to health and/or fecundity. Multiple stressors can be far deadlier than one and laboratory experiments address only a small part of the complexity that occurs in nature (Sih et al. 2004).” Page 95

Conservation Measures (Habitat Related)

“1.1 Rebuild depleted populations of salmon and other prey to ensure an adequate food base for recovery of the southern residents.”

“1.1.1 Support salmon restoration efforts in the region.”

“1.1.1.1 Habitat management--Preservation, restoration, and rehabilitation of degraded freshwater, estuarine, and shoreline habitats is a major emphasis of salmon restoration programs and involves numerous activities, such as reforestation of riparian zones, installment of woody debris in stream channels, removal of fish passage barriers and other structures affecting habitat, and land acquisition.” Pages 100-102.

Photos: [Southern Resident Killer Whales](#) in South Puget Sound where aquaculture is significantly expanding.

m. A New View of the Puget Sound Economy—The Economic Value of Nature’s Services in the Puget Sound Basin

http://www.eartheconomics.org/A_New_View_of_the_Puget_Sound_Economy.pdf

“The Puget Sound economy and the quality of life for our citizens depends on healthy “natural capital.” This report is the most comprehensive valuation of ecosystem services in Puget Sound to date. However, this is only a beginning of analysis. This study should not be taken as the final word on ecosystem service valuation for the Puget Sound Basin but as a first step towards understanding the significant contributions that functioning ecosystems make to the economic well being of the region. **What can clearly be concluded is that even with the incomplete estimates that we present, the value of the annual flow of ecosystem services to residents of the Puget Sound is vast, in the billions of dollars annually. The value of this flow of benefits, analogous to a “capital asset” value of the Puget Sound basin is also vast. The “asset” value of Puget Sound ecosystems is at least on the order of hundreds of billions, and into the trillions of dollars if their value to future residents is counted.** The natural assets of the Puget Sound basin are not immutable. They can and are being lost. This threatens our economy and quality of life.” Page 63.

Section 4: International Aquaculture Studies

Impacts on Birds

Effects on birds related to disturbance, restricted food supply, change in migratory pattern. Certain native species compete for the limited number of low tides during the year.

- a. [A Review of the Ecological Implications of Mariculture and Intertidal Harvesting in Ireland](#), M. L. Heffernan, 1999

Pages 75-92 are most relevant as they outline the impacts of clam and oyster culture on marine birds in particular.

- b. [Potential impacts of mechanical cockle harvesting on shorebirds in Golden and Tasman Bays, New Zealand](#), DOC SCIENCE INTERNAL SERIES 19, Frances Schmechel, 2001

"...there are two main types of impacts likely from harvesting-direct, through removal of cockle biomass and thereby a direct food source of shorebirds and indirect, through impacts on non target species which provide food, or from disturbance to birds of the harvest activity" -page 17.

- c. [Effects of Aquaculture on Habitat Use By Wintering Shorebirds in Tomales Bay, California--California Fish and Game](#)

"Pacific oyster, *Crassostrea gigas*, culture alters spatial habitat structure by introducing shellfish, racks, stakes, culture bags, marker poles, and other equipment onto open flats."

"Our results suggest a net decrease in total shorebird use in areas developed for aquaculture." Page 160.

This report provides a comprehensive analysis of the various bird populations and the specific effects.

Habitat Modification Impacts

- a. [Review of the environmental impacts of intertidal shellfish aquaculture in Baynes Sound](#), G. S. Jamieson, 2001 <http://govdocs.aquaculture.org/cgi/reprint/2004/410/4100110.pdf>

"Habitat modification and the covering of the substrate with predator exclusion nets may thus adversely impact the production of harpacticoid copepods and other important epibenthic organisms, and hence adversely impact the feeding of salmon rearing in the area." Page 44.

"A shift to a system dominated by a cultured species is expected. What proportion of the natural ecosystem might be shifted to one of farmed bivalves without a significant disruption in natural ecosystem processes?" Page 41.

This document provides a thorough overview of the aquaculture process from planting to harvesting.

b. Effects of Shellfish Aquaculture on Fish Habitat, C. W. McKindsey, 2006 [Canadian Science Advisory](#)

"Field studies reported in the same study found that mussels consumed (based on stomach content analysis) copepods (<1.5 mm), crab zoeas (2mm), fish eggs (1-2mm), and even amphipods (5-6mm). Subsequent to this, Lehane and Davenport (Lehane and Davenport 2002) showed that mussels consumed organisms up to 3mm in length and that cockles (*Cerastoderma edule*) and scallops (*Aequipecten opercularis*) are also capable of consuming considerable quantities of zooplankton, both when suspended in the water column and when on the bottom. The size classes of organisms consumed in these studies suggest that the larvae of most commercial species may be at risk from this type of predation." Pages 25-26.

Detailed information includes cumulative reduction of feeding grounds, competition for phytoplankton, bivalve consumption of essential copepods & larvae, accumulation of bivalve feces.

c. Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve mollusks, Dr. Roger Newell, 2004 <http://hpl.umces.edu/faculty/newell/ecobivalve2.pdf>

"Environmental conditions at bivalve aquaculture sites should be carefully monitored, however, because biodeposition at very high densities may be so intense that the resulting microbial respiration reduces the oxygen content of the surrounding sediments. Reduction in sediment oxygen content can... be toxic to the benthos." Page 1.

d. Changes to natural organisms in the beach sediments--[Contrasting the community structure and select geochemical characteristics of three intertidal regions in relation to shellfish farming](#). L.I. Bendell-Young, 2006

"The intertidal regions that had been used for farming for 3-5 years had lower species richness, different bivalve composition, abundance and distribution and a foreshore community dominated by bivalves as compared to the intertidal region where no active farming occurred. Beaches that were actively farmed also had a greater accumulation of organic matter and silt."

Need for Scientific Assessment of Carrying Capacity

a. [Integrated Assessment of Ecosystem-scale carrying capacity in shellfish growing areas](#)

"It is important to assess the carrying capacity of an area prior to the establishment of large-scale shellfish cultivation, to ensure an adequate food supply for the anticipated production and to avoid or minimize any ecological impacts."

Additional studies can be found at:

[ProtectOurShoreline - Studies](#) - Intensive Shellfish Aquaculture

Section 5: Aquaculture Industry Elimination Of Native Species

According to the [Pacific Shellfish Institute Goals and Priorities](#) 2015

PCSGA has the goal of conducting research on:

“Integrated Pest Management (IPM) of burrowing shrimp, European green crab, red rock crab, Dungeness crab, shore crab, diving ducks, starfish, oyster drills, gulls, crows and moon snails by use of deterrents, exclusion or destruction.”

Per Taylor Shellfish Environmental Codes of Practice 12-22-08--Page 26.

"In some growing areas, burrowing ghost (*Neotrypaea californiensis*) and mud (*Upogebia pugettensis*) shrimp are the main pest, particularly in Willapa Bay. These areas are treated by spraying carbaryl, a non-persistent pesticide. The types of predators include Japanese drills, moonsnails, and a variety of nematodes, echinoderms, crustaceans, fish and birds." "In some areas, duck predation is significant. As a last alternative to control, harassment, hazing and hunting is conducted."

Many species named above, identified by PCSGA and Taylor Shellfish as “pests “ and “predators,” are indigenous to Puget Sound and are key elements to the natural ecosystem. Surf scoters have already declined more than 50% in the last 25 years and industry's "predator" methods for these migratory birds undermine the conservation efforts being funded by national organizations.

An integral part of the “Puget Sound Treasure” is the aquatic life that even the Department of Fish and Wildlife cannot protect from elimination by the aquaculture industry. According to the Department of Fish and Wildlife: “The primary rule is [RCW 77.12.047](#)(3). This exempts private commercial aquaculture from just about everything the WDFW does.”

Section 6: Aquaculture Industry Introduction of Plastic Pollution

Since the late 1990's, industry has been introducing large quantities of non marine grade plastics such as PVC, plastic grow bags etc that are used in their operations and have escaped their farm sites. 100' of 6" schedule 40 (wall thickness = .280) PVC pipe, such as that used in geoduck aquaculture, weighs in at 353 pounds. Thus, 8 miles of PVC pipe weighs in at about 150,000 pounds total per acre. PVC lengths and weights. See [PVC and CPVC Pipes - Schedule](#)

No state or county agency has required independent testing of this unprecedented amount of plastic in the nearshore environment. The following links outline the growing alarm among researchers of the multiple impacts of plastics on marine waters/animals:

a. Organotin is a toxic compound used in the production of PVC pipes as described in ["Organotin – Environmental fate and effects"](#)

The scientist who forwarded this research to us made the following statement:

"I have provided sections of the definitive work on Organotin compounds and their fate and effect in the environment. Some conclusions can be reached:

- Organotin compounds, some in concentrations in the low parts per trillion, are toxic to shellfish (Pages 14-22).
- PVC pipe contains 0.5-10% organotin as a PVC stabilizer
- Organotin leaching occurs in PVC pipes (Page 594)

Suggest you read through the material and draw your own conclusions. As for myself, I wouldn't use PVC in the marine environment if there was an alternative."

b. The City of Seattle has rejected PVC pipe in its latest green projects: ["The City of Seattle Rejects PVC Pipe in Favor of Environmentally Friendly Choice"](#)

c. New York State and the City of San Francisco, among others, have also banned PVC pipe: ["PVC in Buildings: Hazards and Alternatives"](#)

Throughout its entire life cycle, from manufacturing to disposal, PVC has high environmental costs. It contains a high percentage of chlorine, is made with the carcinogen vinyl chloride plus dioxin and ethylene dichloride are by-products of its manufacture. PVC is not readily recyclable and when incinerated releases both the carcinogen dioxin and hydrogen chloride gas.

Section 7: Aquaculture Industry Introduction and Use of Invasive Species

Excerpts from "[Assessing the global threat of invasive species to marine biodiversity](#)":

"The Pacific Oyster has been intentionally released and cultured in coastal waters around the world. It can dominate species and destroy habitat (Ecosystem Threat-3- Disrupts multiple species some wider ecosystem function and/or keystone species or species of high conservation value (e.g. threatened species). Gallo Mussel (Highest Ecosystem Threat-4-Disrupts entire ecosystem processes with wider abiotic influences).

"71% of non native species documented in our eco-region (Oregon, Washington Coast, Puget Sound) were introduced by aquaculture." "In this region policy makers, conservation practitioners and the aquaculture industry should continue to work together to prevent any future invasions and by improving practices and perhaps limiting new operations."

Pacific Oysters

Despite the US Ecological Society warning, industry continues to demand unlimited expansion of Pacific oysters in Washington and decision makers have not restricted operations to date.

Gallo Mussel

Gallo mussel has the highest Ecosystem Threat rating of 4, but Taylor Shellfish sells the spat at their retail stores and there are no regulatory restrictions on expansion. While they are included on the Marine Invasive Species Identification June 2009 guide, they are not listed as a species of concern on the Washington invasive species watch list. Adverse impacts of mussel operations, especially in low flushing water bodies like South Puget Sound, are well documented in studies as shown below:

[Will the Introduced Mussel *Mytilus Galloprovincialis* Outcompete the Native Mussel *M. Trossulus* in Puget Sound?](#) A study of relative survival and growth rates among different habitats---Michelle Rensel, Joel Elliott, and Peter Wimberger

"The results of this experimental study showed that Mg (Gallo Mussel) had higher survival and growth than Mt in all habitats except the high intertidal, suggesting that Mg has the potential to outcompete Mt (Native Mussel) in the low intertidal and low subtidal zones in areas of high salinity. Further research is required to determine whether Mg or hybrids between Mg and Mt will have a significant influence on populations of the native mussel Mt in Puget Sound."

Impacts of mussel (*Mytilus galloprovincialis*) farming on oxygen consumption and nutrient recycling in a eutrophic lagoon

<http://www.springerlink.com/content/j0186q2275345v11/>

"Overall, whilst grazing by the mussel rope community could act as a top-down control on the phytoplankton, most of the ingested organic matter is rapidly recycled to the water column as inorganic nutrients, which would be expected to stimulate phytoplankton growth. Consequently, the net effect of the mussel farming on phytoplankton dynamics may be to increase phytoplankton turnover and overall production, rather than to limit phytoplankton biomass."

[Benthic Organic enrichment from suspended mussel \(*Mytilus edulis*\) culture in Prince Edward Island, Canada, April 23, 2009](#)

"The significant increase in hypoxic and sulfidic sediments within mussel farms between 1997 and 2001 is consistent with the 43% increase in PEI mussel production—a classic response to excessive organic biodeposition in shallow coastal inlets with relatively low dispersive capacity."

[An Overview of Factors Affecting the Carrying Capacity of Coastal Embayments for Mussel Culture](#)

"In poorly flushed areas, limited exchange of oxygen within the surface sediments can rapidly lead to anoxic conditions, as the demand for oxygen exceeds the rate of exchange of pore water. In these circumstances, benthic metabolism becomes increasingly anaerobic. Severely affected areas are characterized by films of chemoautotrophic sulphur bacteria (*Beggiatoa*) at the sediment-water interface and black, anoxic sediments (Grant et al. 1995). The by-products of anaerobic metabolism, including sulphide (usually in the form of H₂S, produced as result of anaerobic sulphate reduction) and ammonium (produced by anaerobic and aerobic mineralization of organic matter) build up in the sediments." Page 9.

Gallo Mussel Raft Expansion In Totten Inlet

Thurston County required Taylor Shellfish in 1999 to complete a Gallo Mussel Environmental Impact Statement. Taylor was allowed to retain the 21 mussel rafts they had placed in Totten Inlet, but was not allowed at that time to continue their expansion plan to add 79 more mussel rafts. Taylor recently submitted a draft EIS to Thurston County in September 2009.

http://www.co.thurston.wa.us/permitting/Hearings_Examiner/Decisions/1999/980809d.pdf

APHETI, the local citizen organization, requested the EIS and opposed expansion of gallo mussels. On 11/03/06, APHETI divers documented *Beggiatoa* bacteria underneath the existing Taylor rafts and invasive tunicate colonies of *Didemnum* covering the mussels. This information was sent to the Department of Natural Resources, but this DNR subtidal lease was subsequently renewed.

[See photos.](#)

State and county officials have allowed intertidal and raft aquaculture to expand in Totten Inlet to 31 out of 33 shoreline miles. Jeff Schreck, DNR land manager responsible for aquaculture leasing, stated in November 2006 that: "Totten is in bad shape; it might go eutrophic." Key Peninsula News (Eutrophic Definition: Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms)

For more information, visit the [APHETI website](#)

Section 8: Marine Fish Farming

The devastating impacts of open cage fish farming are well documented around the world and supported by abundant studies. Pollution, chemicals flush from the open cages while parasites and pathogens threaten nearby migrating marine life. Recent outbreaks of disease and sea lice infestations have been widely reported, especially in Canada and Chile. Caged fish are fed pellets of mackerel, sardines and anchovies, taking essential food from human populations around the world while depleting the marine food chain. Between 3-5 pounds of small fish are required to grow 1 pound of caged salmon. Other species in experimental production require up to 20 pounds of small fish for each pound of growth.

An invasive species in the Pacific region, Atlantic salmon are raised in aquaculture operations in Chile, British Columbia and Washington. In four years, more than 613,000 non native Atlantic salmon escaped from privately owned net pens into Puget Sound.

Washington is targeted for more aquaculture according to the "NOAA Aquaculture Program, Sept 2007 —Washington Aquaculture Opportunities for Growth." Species listed are: Blackcod (New species), Culture of salmon & steelhead, shellfish production of oysters, mussels, clams and geoduck.

The "National Offshore Aquaculture Act" has been introduced into Congress and would open our Exclusive Economic Zone, three to 200 miles offshore to privately owned fish farms.

Section 9: Current Geoduck Research in Washington

While SeaGrant is doing limited research on geoduck aquaculture, we have not found other independent comprehensive scientific assessments of the short-term or long-term impacts of existing aquaculture or continued expansion. The SeaGrant September 2007 Shellfish Aquaculture Workshop expert scientists recommended the following but there is no evidence that any of their recommendations have been followed:

- Monitoring existing sites for environmental impacts
- Collecting baseline studies, mapping, looking at regions and habitat slated for development
- Developing ecological carrying capacity models to assess the influence on ecosystem processes.
- Consideration of social carrying capacity before industry expansion. Review the extensive list of recommendations at the following Sea Grant site:

http://www.wsg.washington.edu/research/geoduck/shellfish_workshop.html

Current Sea Grant Research Efforts Underway

The SeaGrant geoduck preliminary research results were presented on 2/26/09 and are outlined in their following links. Officials should consider these preliminary results just as the many preliminary or non peer reviewed results distributed by the industry.

[Geoduck Aquaculture Investigations in Puget Sound](#) by Glenn R. VanBlaricom

"In the intertidal benthic habitats of Puget Sound, the species types are usually crustaceans, polychaete worms, and small bivalves. The densities can be extraordinary, often in excess of 10,000 individuals per square meter. Animals are typically small, which sometimes gives to the mistaken impression that they are unimportant ecologically."

[Local Effects of Geoduck Aquaculture](#) on a meadow of intertidal eelgrass in Samish Bay, Washington, by Micah Horwith, Dr. Jennifer Ruesink 2/26/2009

Preliminary Results of the SeaGrant Geoduck Aquaculture Investigations:

The preliminary results of the SeaGrant studies from February include the Micah Horwith study on geoduck aquaculture's effects on eelgrass in Samish Bay and Glenn VanBlaricom's study outlining the results of the sediment core analysis, mainly at the Foss Farm location. In the case of eelgrass, the Horwith study demonstrated a statistically significant reduction in both eelgrass density and shoot size after geoduck harvest activities. Geoduck harvest also demonstrated a significant reduction in eelgrass reproduction (flowering), and a significant reduction in sediment organic content (an important food source for infauna) after geoduck harvest.

In the case of sediment core analysis, the study found a significant reduction in all densities of infauna, including Corophium and polychaetes (both important food sources for endangered Chinook). Sand dollar size and density were also significantly reduced by geoduck harvest activities. The presence of Sand Lance was also noted in the geoduck site at Foss.

Data Gap Analysis

Concerns and questions relevant to infaunal and epibenthic impacts of geoduck aquaculture that have not been answered as geoduck expansion continues - Dethier, Leitman and Mathews: “Seeding of young geoducks in netted PVC tubes on the beach is likely to alter local physical and biological conditions, both those on the surface of the sediment and those in the sediment.”

See [Concerns and Questions Relevant to Infaunal and Epibenthic Impacts of Geoduck Aquaculture](#)

Section 10: Lack of Aquaculture Environmental Regulatory Requirements: Army Corp of Engineers Nationwide Permit 48, Department of Ecology, Washington Dept of Health, Washington Department of Fish & Wildlife

Army Corp of Engineers NWP48

According to the Pacific Shellfish Institute 2015 Goals and Priorities: “Explore options under the Endangered Species Act (ESA) Sections 7 and 10, to develop a regional general permit in cooperation with the Army Corp to provide growers with protection from prosecution under the ESA, Clean Water Act, Rivers and Harbors Act and Marine Mammal Protection Act.”

Industry did lobby for this NWP48 protection and it was issued in April 2009. The following links to the consultations were issued that describe industry practices and the negative impacts.

[National Marine Fisheries NWP48 Consultation](#)

“Initially, NMFS determined that the proposed action is likely to adversely affect LCR Chinook salmon (Chum salmon, Puget Sound Chinook salmon, and the southern DPS of green sturgeon. During consultation, NMFS concluded that while actions conducted under the proposed NWP48 would have environmental effects, these effects were not reasonably certain to impair normal behaviors resulting in their actual injury or death.” Letter, Page 2.

Could the continual lobbying by the Shellfish industry be one reason for this switch in policy?
According to the East Coast Shellfish Growers Association Newsletter regarding NMFS:

“We were especially concerned about the negative tenor displayed in comments submitted by NMFS’ habitat division which seem to ignore NOAA’s stated goal of supporting growth of domestic aquaculture.” ([ECSGA Newsletter](#) Page 4)

Link: US Fish and Wildlife Consultation

http://www.fws.gov/westwafwo/publications/Biological_Opinions/2008_F_0461_BO.pdf

“This opinion will address and evaluate effects to bull trout within the Coastal-Puget Sound Interim Recovery Unit (Puget Sound IRU) as well to designated critical habitat for the bull trout. We also address adverse effects to marbled murrelets.”

This NWP48 opinion relied on a substantial amount of preliminary, non-peer reviewed data that the majority was supplied by or through the aquaculture industry, no data was presented that is specific to geoduck aquaculture in South Puget Sound and did not require independent scientific assessments or cumulative impact assessments. The opinion is extremely limited in scope on the effects on our Washington aquatic native species and organisms. Steelhead was not fully addressed because critical habitat has yet to be established.

It should also be noted that this NWP48 allows up to 3 tons of Carbaryl pesticide (Sevin) to continue to be sprayed annually by airplane over approximately 800 acres throughout Willapa Bay/Grays Harbor tidelands. The adverse impacts of spraying carbaryl for over 40 years are well documented by the Washington Toxics Coalition and other scientists.

Department of Ecology—Aquaculture guidelines

<http://apps.leg.wa.gov/WAC/default.aspx?cite=173-26-241>

These Department of Ecology guidelines do not recommend or require permitting for shellfish aquaculture and counties have been able to allow aquaculture to expand without environmental regulation. Ecology sent out in September 2009 the Shellfish Aquaculture Regulatory Committee (SARC) published general recommendations regarding geoduck aquaculture. To date, Ecology has not emphasized the need for aquaculture regulation during the Shoreline Master Program Update process.

Washington Dept of Health

This state agency has no environmental regulation authority over aquaculture.

Washington Dept of Fish and Wildlife

This state agency has no environmental regulation authority over aquaculture.

Washington Dept of Agriculture

This state agency has no environmental regulation requirement for aquaculture.

Section 11: Current Litigation Regarding Habitat Protection

Puget Sound--Environmental Protections, Cumulative Impact Analysis, Maury Island Judge's Decision & Briefs-June 2009

<http://preserveourislands.org/blog/wp-content/uploads/2009/06/federal-brief-final.pdf>
<http://preserveourislands.org/blog/?p=38>

Judge Martinez wrote in his ruling. "No single project or human activity has caused depletion of the salmon runs or the near extinction of the Southern Resident Orca, or the general degradation of the marine environment of Puget Sound. Yet every project has the potential to incrementally increase the burden upon the species and the Sound."

Canada--2/25/09--"Lawsuit forces Canada to protect endangered killer whales. The federal government issued an Order that will provide legal protection for the endangered species habitat." There have been policy decisions from the feds and they can be found here:

http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=699#docs

Past Litigation—Decisions Regarding geoduck aquaculture

Washington Shellfish—Pierce County

[Washington Courts - Court of Appeals Division - docket 32471-7-II](#)

"...had caused substantial interference with the public use of surface water, harvested geoducks in water less than 18 ft deep, contrary to RCW 77.60.070, operated in eelgrass beds and continued to operate illegally without permits."

Foss/Taylor Shellfish--Pierce County Hearings Examiner Decision

[Amended Report and Decision](#) Case AA16-07

24. "...the tubes and the netting are a protective device. They are a structure..."
26. " According to Megan N. Dethier, PHD, University of Washington, the harvest of geoducks from high density aquaculture beds will involve near total liquefaction of the sediment of at least 50cm. While organisms in the intertidal zone are adapted to small scale disturbance (from waves, ghost shrimp, crab pits, etc) the large scale physical disturbance is not part of the environment's evolutionary history."
27. "The issue would be whether or not liquefying approximately one acre of beach from about three foot plus level in depth constitutes dredging. It definitely does result in the removal of geoduck from the bottom of the sand and it also results in the floating of sand from the area. It definitely does constitute relocation of sand within the areas although the amount is unknown. Harvesting definitely does result in sand being displaced and removed."

28. "During high tide the tubes and net obstruct the use of shallow water of Puget Sound by watercraft, such as kayaks, canoes, shallow draft motorboats, intertubes and fishermen. The tubes and nets also obstruct use by windsurfers, divers and fishers. The obstructive nature of operations increases during planting and harvesting when barges, workers, hoses and other equipment are present."

32. "Certainly anyone using the water and entering into this area during planting, harvesting on the time period when the tubes and nets are present could be in jeopardy." Pages 28x-30x

"On October 26, 2007, the Pierce County Council amended the provisions of the Pierce County Code Chapter 20.24 governing aquaculture operations. The new provisions retained the requirement for a shoreline substantial development permit for geoduck operations. " Page 31x.

Social Carrying Capacity and Impacts

Section 12: Social Carrying Capacity & The Public's Right to the Shorelines

The Public Trust Doctrine and The Shoreline Management Act

[Review of recent carrying capacity models for bivalve culture and recommendations for research and management](#)

"In this report, we discuss and outline four hierarchical categories of carrying capacity studies: physical, production, ecological, and social carrying capacity."

Scientists regard social carrying capacity in this report as an integral part of the decision making process while industry uses derogatory labels for citizens such as "NIMBY's which changes the focus of the discussion.

Public Trust Doctrine

The '[Public Trust Doctrine and Coastal Zone Management in Washington State](#)' with examples of pertinent case law:

"Simply stated, the public trust doctrine provides protection of public ownership interests in certain uses of navigable waters and underlying lands, including navigation, commerce, fisheries, recreation and environmental quality. While tidelands may be sold into private ownership through conveyance of the jus privatum, the public trust doctrine reserves a public property interest, the jus publicum, in these lands and waters flowing over them." Page 1.

"This public interest is a property right, like an easement. If the state wished to control the use of this burden, including use by either the private owner or by the public, the state is merely controlling a right that it already owns. It is not regulating private property." Page 2.

"The Washington Supreme Court has described the public trust doctrine as similar to a covenant running with the land. Unlike other burdens on private property, however, landowners need receive no express notice of the public trust burdens on their lands." Page 67.

Washington State Department of Ecology Public Trust

http://www.ecy.wa.gov/programs/sea/sma/laws_rules/public_trust.html

"The Public Trust Doctrine is a legal principle derived from English Common Law. The essence of the doctrine is that the waters of the state are a public resource owned by and available to all citizens equally for the purposes of navigation, conducting commerce, fishing, recreation and similar uses and that this trust is not invalidated by private ownership of the underlying land. The doctrine limits public and private use of tidelands and other shorelands to protect the public's right to use the waters of the state."

Putting the Public Trust Doctrine to Work. The Application of the Public Trust Doctrine to the Management of Lands, Waters, and Living Resources of the Coastal States. 1990. Prepared by David C. Slade, Project Manager, National Public Trust Study, and the Coastal States Organization, Washington D.C., and the University of Massachusetts.

“Recognized public uses of trust lands today include fishing, bathing, sunbathing, swimming, strolling, pushing a baby stroller, hunting, fowling, both recreational and commercial navigation, environmental protection, preservation of scenic beauty, and perhaps the most basic use, just being there.” P xxi

“In all States, the Public Trust Doctrine assures the public some right of lateral access along shorelands between the ordinary high and low water lines. For the most part, the public’s lateral access includes recreational use of the shorelands.” P xxvii

“As noted, the jus publicum interest in trust lands cannot be conveyed or alienated to private ownership, for the State cannot abdicate its trust responsibilities to the people. The jus privatum interest, however, may be and often is, conveyed into private ownership. There are strict limitations upon the State in order to convey the jus privatum to private ownership. The legislature must act through legislation to authorize the conveyance. The conveyance must be described in clear and definite language, with all ambiguities construed in favor of the State and against the grantee. The conveyance must primarily further the public interest, with benefits to private parties being secondary or corollary. There must be no substantial impairment of the public interest in the lands and waters remaining. Non compliance with any of these requirements violates the Public Trust Doctrine, and can render the conveyance void.” P xxii

“...all of the public’s trust rights are dominant to the private rights.” P xxiii

“...the public’s jus publicum rights are superior to any jus privatum rights” P xxix

“Waterfront property owners commonly regard their property as extending to where the water is, unaware that the State has a reserved jus publicum interest up to the ‘ordinary high water mark.’” P xxiii

“...although much trust land is privately owned, these private rights in trust land are for the great part subject to the dominant rights of the public to use these same lands for a wide variety of recognized uses.” “The Public Trust Doctrine is applicable whenever navigable waters or the lands beneath are altered, developed, conveyed, or otherwise managed or preserved. It applies whether the trust lands are publicly or privately owned.” P xxxii

“The living resources, e.g. the fish and aquatic plant and animal life, inhabiting these lands and waters are also subject to the Public Trust Doctrine.” P 1

“The Public Trust Doctrine has been recognized and affirmed by the United States Supreme Court, the lower federal courts and State courts from the beginning days of this country to the present.” “The trust has a clear and definite beneficiary: the public.” P 4

“The shores are not understood to be property of any man, but are compared to the sea itself, and to the sand or ground which is under the sea.” Institutes of Justinian 2.1.5. P 5

“Throughout history, the shores of the sea have been recognized as a special form of property of unusual value; and therefore subject to different rules from those which apply to inland property.”
Boston Waterfront Development Co. v. Commonwealth, Mass. (1979) P 6

“...public trust lands may be privately used so long as the use promotes the public welfare” P 252

See [Shoreline Management - Symposium Proceedings](#) Everett, Washington, Dec 13 -14, 1991
Per Brian Boyle, Public Lands Commissioner

“For the average family, a walk on the beach is a free and easy amusement. It’s something most of us take quite for granted. To a public land manager, however, that same walk represents the exercise of a right with roots that can be traced back through the foundation of our state, to the foundation of our republic, and beyond that to the laws of England and the statutes of the Roman Empire.”

“Our walk on the beach is, in fact, defended by a legal doctrine more than 1,500 years old – a doctrine that holds that the land between the tides and under navigable waters is inalienably dedicated to public use. This is the famous public trust doctrine, and a whole string of court decisions, both at the federal and state levels, have confirmed its validity for the present day.”

“...when the state limits what private property owners can do with their property, as in zoning restrictions, property owners may object that the state has taken some part of the values of their property without compensation, which is a violation of the constitution. But the situation is very different when the state acts to protect its own property, or the property rights it holds in trust for the people under the public trust doctrine. Potentially, this is a much more powerful means of securing public rights, against which the “taking” argument has no effect. The Washington State Supreme Court held in the Orion case that private owners can expect no economic benefit from their lands if obtaining that benefit deprives the public of rights it holds under the public trust doctrine.” Page 123.

Comments from Shoreline Staff at Department of Ecology

See [comments from DOE](#)

“This opinion (AG opinion of geoduck aquaculture) raises a number of questions for me. The Clamshacks case comes immediately to mind, since I am having difficulty reconciling that historic decision with the subject AG’s opinion.”

“Anyone who ever fly fished the South Puget Sound nearshore for sea run cutthroat and silvers (Coho salmon), or has ambitions to do so, will tell you that the first point bulleted below (AG opinion on geoduck aquaculture and the public’s use of the water), is also suspect, and probably outright erroneous. The (AG) opinion contains a very familiar error in conceiving that ‘normal public use’ is always associated with a park or similar public facility. The public trust doctrine rests on, and arises from, the fact that ancient and modern societies have used, and continue to use the entire surface and water column of marine and fresh waters for many millennia, albeit at varying degrees of intensity for different purposes.”

Taxation of Public Trust Tidelands

Shoreline owners are assessed waterfront taxes based on the frontage foot and are not assessed taxes on tidelands that are part of the upland property. Separate tideland parcels or Bush/Callow tidelands are assessed generally less than \$3.00 per acre per year. If these tidelands are used for commercial purposes and are revenue generating, they should be paying commercial tax rates. These virtually non-existent tax rates are consistent with the fact that Washington tidelands are held in trust for the people under the Public Trust Doctrine.

Public Trust Rulings in Other States

California State Lands Commission

http://www.slc.ca.gov/Policy_Statements/Public_Trust/Public_Trust_Doctrine.pdf

“The origins of the public trust doctrine are traceable to Roman law concepts of common property. Under Roman law, the air, the rivers, the sea and the seashore were incapable of private ownership; they were dedicated to the use of the public. This concept that tide and submerged lands are unique and that the state holds them in trust for the people has endured throughout the ages.”

Nevada Supreme Court

<http://www.ptdim.com/environmental-protection.html>

“The public trust is more than an affirmation of state power to use public property for public purposes. It is an affirmation of the duty of the state to protect the people’s common heritage of streams, lakes, marshlands and tidelands, surrendering that right of protection only in rare cases when the abandonment of that right is consistent with the purposes of the trust. Our dwindling natural resources deserve no less.”

Center for Environmental Law and Policy http://www.celp.org/water/celpaward/Benella_Caminiti.html

“While the state may convey title to tidelands and shorelands, the private owner does not receive the ‘full bundle of sticks’ that all first year law students learn about in property law. Instead, the state retains a ‘jus publicum’ or public easement on the lands. The state may no more dispose of these public rights than it may abdicate its police powers to run the government or preserve the peace.”

Public Trust According to NOAA <http://www.csc.noaa.gov/ptd/>

Recreation

“The right of the public to use Public Trust lands and waters for recreational purposes is recognized in most states as traditional.”

Environmental Protection

"The preservation of Public Trust resources is an extension of the protection of public uses of these resources, and has been recognized in several states as a trust responsibility."

Applicable Waters and Shorelines

"In general, the following are subject to the Public Trust Doctrine:

- Tidewaters to their farthest reaches
- Tidelands
- Navigable-in-fact waters
- Permanently submerged lands, including those extending seaward to the limit of state ownership"

The Shoreline Management Act

[Shoreline Management Act RCW 90.58.020](#)

"...the public's opportunity to enjoy the physical and aesthetic qualities of natural shorelines of the state shall be preserved to the greatest extent feasible..."

"Alterations of the natural conditions of the shoreline of the state, in those limited instances when authorized, shall be given priority for...development that will provide an opportunity for substantial numbers of people to enjoy the shorelines of the state."

"...uses shall be preferred which are consistent with control of pollution and prevention of damage to the natural environment."

"Permitted uses in the shorelines of the state shall be designed and conducted in a manner to minimize, insofar as practical, any resultant damage to the ecology and environment of the shoreline area and any interference with the public's use of the water."

See [Shoreline Management - Symposium Proceedings](#) Everett, Washington, Dec 13 -14, 1991

Joan K. Thomas, one of the original drafters of the SMA, wrote the following in 1991:

"I have thought about this carefully over the years as I have seen my expectations frustrated. We have lost the full potential of the SMA to protect a valuable resource through fainthearted administration."

"When the SMA was written in 1971, aquaculture meant oysters and clams, and one salmon raising operation. This activity was recognized and protected as water dependent. I do not read the original intent or the original guidelines to promote the industry as we know it today. In fact, the guidelines specified that navigational access not be restricted and that visual access of upland owners be considered. Aquaculture has become a sore point between local governments and the Department of Ecology – a fraying of the partnership." Page 13.

Section 13: Human Health Concerns---Shellfish

Washington's Department of Health **ONLY** Tests Routinely for Fecal Coliform

a. [The Ten Riskiest Foods Regulated by the US Food and Drug Administration](#) - Findings—Oysters
Rank #4 in the Top Ten Foods

Oysters - 132 outbreaks involving 3409 reported cases of illness.

“Illnesses from oysters occur primarily from two sources: **Norovirus and Vibrio**. Although Norovirus in other foods is usually associated with improper handling during harvest or preparation, oysters can actually be harvested from waters contaminated with Norovirus. When served raw or undercooked, those oysters can cause gastroenteritis, an inflammation of the stomach and small or large intestines.” Page 4

“The most dangerous of the two pathogens found in oysters is **Vibrio**. This hazard is a type of bacterium in the same family as cholera. The most common strain in the US are V. Vulnificus and V.parchaemollicus, both of which can cause severe disease. In immuno-compromised persons, particularly those with chronic liver disease, V.vulnificus can infect the bloodstream, causing a severe and life-threatening illness characterized by fever and chills, decreased blood pressure (septic shock), and blistering skin lesions. V. vulnificus bloodstream infections, called septicemia are fatal about 50 percent of the time.” Page 5

FDA Plan Limits live-oyster sale from Gulf in warm months

http://www.usatoday.com/news/health/2009-10-18-oysters-fda-plan_N.htm

Experts flee French town after threats

<http://www.telegraph.co.uk/news/worldnews/europe/france/6183593/Oyster-experts-flee-French-town-after-threats.html>

b. **Shellfish Pesticide/Herbicide Residue Tolerances**

“Carbaryl (Sevin insecticide) is sprayed by shellfish growers in Washington State (Willapa Bay) directly in estuaries and on mudflats to kill ghost shrimp. As a result, EPA allows oysters containing up to 0.25 parts per million (ppm) of carbaryl to be consumed by the public.” Page 1.

“Glyphosate is is sprayed by shellfish growers in Washington State directly in estuaries and on mudflats to kill Spartina, a form of cord grass. As a result, EPA allows shellfish containing up to 3.0 ppm of Glyphosate and fish containing up to 0.25 ppm to be consumed by the public.” Page 1.

“Imazapyr is sprayed by shellfish growers in Washington State directly in estuaries and on mudflats to kill Spartina, because Glyphosate was not doing the job. EPA allows fish to contain up to 1.00 ppm and shellfish 0.10 ppm of Imazapyr. Milk has an Imazapyr tolerance of 0.01 ppm!” Page 1.

For details see: [Carbaryl and Glyphosate Tolerances](#)

c. Cadmium

[Consumers should be informed of the health risks of consuming cadmium contaminated oysters](#)

According to the Pacific Coast Shellfish Growers Voice Article-May 2009

http://www.taylorshellfishfarms.com/files/file/VOICE_May09_ShellfishUpdateAndClr.pdf

“Nature’s Cleaning Service”

“Shellfish provide a critical function in the ecosystem through the biofiltration that occurs as part of their feeding activities. The ability of shellfish to purify the water column can be used as a means for effectively mitigating the impacts of anthropogenic activities and development on the shorelines that promote excessive nutrient enrichment. Shellfish aquaculture may provide the most economical and environmentally suitable means for offsetting shoreline development and pollution. Case in point, representatives from Chesapeake Bay look to Washington for ways to grow shellfish in order to clean up their polluted water.”

Our Public Health Concern

Consumers should be concerned about the health of shellfish they are eating when industry resists testing and labeling of their products for consumer protection.

Section 14: Washington Organizations' Aquaculture Policies

Sierra Club

Aquaculture Policy and Flyer

<http://cascade.sierraclub.org/directory/committees/water>

Sierra Club—Threat to Drakes Bay National Park ecology by oyster lease

<http://www.savedrakesbay.org/>

Other organizations that have called for Puget Sound aquaculture regulation include:

- Vashon Island Community Council -- Moratorium
- Anderson Island Park & Recreation District and Quality of Life Committee -- Moratorium
- Tahoma Audubon Society -- Geoduck Moratorium Policy Paper
- Washington Council of Trout Unlimited -- Environmental Impact Study
- People for Puget Sound -- Intertidal Geoduck Policy
- Ministry of Agriculture and Lands of British Columbia (Note: statement on its website; "Applications for new intertidal geoduck aquaculture are not being accepted due to gaps in understanding of geoduck aquaculture techniques on fish habitat.")

Section 15: Taxpayer Funds Used for Government Grants that Enrich One Private Aquaculture Company

While it is well known that Federal grants using taxpayer funds are widely used to assist industry expansion, it is of concern that grants using taxpayer funds are continuing to be awarded to enrich one company as is being done with this Taylor Mussel Raft Research:

“This research is supported through National SeaGrant NMAI Award No. NA16RG1591 and the efforts of the following participants: Ralph Elston-Pacific Shellfish Institute, Jonathan Davis—Taylor Resources, Kenneth Brooks—Aquatic Environmental Science Lab, Curtis Ebbesmeyer-Evans-Hamilton, Rita Horner-University of Washington, and Frank Smith Northwest Research Associates.”
Phytoplankton Abundance and Seasonal Change in Response to Utilization by a High Density Mussel Culture System, South Puget Sound, Washington, USA

Section 16: Environmental Organizations Receiving Support from the Aquaculture Industry

People for Puget Sound—Taylor Shellfish--Sponsor

<http://www.pugetsound.org/events/harborlights/harborlights>

Puget Soundkeeper Alliance—Taylor Shellfish Partnering Sponsor

<http://www.pugetsoundkeeper.org/events/community-oyster-roast>

Surfriders—Taylor Shellfish Provides Food for Events

http://www.facebook.com/pages/Shelton-WA/Taylor-Shellfish-Farms/52057107380?v=feed&story_fbid=137964167029

<http://seattle.craigslist.org/oly/eve/1373927357.html>

Futurewise—Taylor Shellfish Provides Food for Events

<http://www.futurewise.org/action/SeattleParticipants>

http://www.facebook.com/pages/Shelton-WA/Taylor-Shellfish-Farms/52057107380?v=feed&story_fbid=139385042582

Section 17: List of Websites For More Information

There are many other studies available that document aquaculture impacts and information can be viewed at the following websites:

[Protect Our Shoreline](#)

[Case Inlet Shoreline Association](#)

[Coalition to Protect Puget Sound Habitat](#)

[Association To Protect Hammersley, Eld and Totten Inlets](#)

[Eyes Over Eld](#)

[Association for Responsible Shellfish Farming \(Canada\)](#)

Section 18: Who is the Coalition To Protect Puget Sound Habitat and why do our members feel they can make a difference in Puget Sound?

Our Coalition is comprised of citizens throughout Puget Sound who are concerned about the future of Puget Sound and feel that all impacts must be included in the discussion if a healthy Puget Sound is the goal. Because we are an all-volunteer non-profit coalition, our protection and restoration efforts are not swayed by the shellfish industry that sponsors free shellfish banquets for environmental groups, fundraising events, and/or provides significant contributions. We have invested considerable funds for research, public awareness and intervening on court cases and intend to continue our efforts until an aquaculture regulatory framework is required in Washington based on independent sound science.

The following will outline a few of our projects:

- APHETI (Association to Protect Hammersley, Eld & Totten Inlets) requested that Thurston County require Taylor Shellfish to submit an Environmental Impact Statement prior to the expansion of Gallo Mussel rafts planned for Totten Inlet. Gallo mussels are an invasive species with the highest ecological impact rating. See [Invasive species](#) section for more details.
- At our request, our state representative, Pat Lantz, sponsored a geoduck aquaculture bill HB2220 in 2007 to require regulation and research on this rapidly expanding aquaculture operation that had no independent scientific assessments conducted. Laura Hendricks served on the Shellfish Aquaculture Regulatory Committee that was providing recommendations to Ecology on geoduck guidelines only. See [Sea Grant](#) section for details.
- We retained an environmental attorney in 2006 who requested an Environmental Impact Statement on the six geoduck farm applications in Pierce County, one of the few South Sound Counties to require permits for aquaculture. These applications are pending with no decision published at this point.
- Case Inlet Shoreline Association (Pierce County) successfully halted a geoduck/shellfish operation in Dutchers Cove, an important pocket estuary in Case Inlet. Photos of orcas that visited that salmon bearing cove are on their website. The tidelands have now been purchased by the Trust for Public Lands where the cove will be protected for the aquatic life and citizens can enjoy the natural beauty.
- Residents of Hammersley Inlet (Mason County) have legally requested that Ecology & Mason County prohibit geoduck nursery plastic pool sites placed on 4 x 8 sheets of plywood in Hammersley Inlet and Spencer Cove. The shellfish operator (Seattle Shellfish) in Spencer Cove has refused to move the over 1,000 plastic pools that are smothering the substrate in Spencer Cove as Mason County and Ecology have required a permit. Taylor Shellfish removed the plastic pools from Hammersley Inlet. Residents have recently taken photos of Orcas swimming in Hammersley Inlet. Cape Horn in Hammersley Inlet is already filled with geoduck aquaculture.
- Residents in Eld Inlet are demanding a no shooting zone as migrating surf scoters are being massacred at the mouth of the inlet in a residential neighborhood. The hunters launched their boat from the property of Paul Taylor. At the Eld Inlet Thurston County Public meeting called to address this issue, the sheriff stated “shots are heard at night over oyster beds to scare off the birds.”

- Our Coalition has actively worked to stop the DNR geoduck intertidal leasing program because most sites were located in forage fish areas. There was no independent science to justify this expansion and it violates the public trust doctrine of restricting public tidelands from public use. We worked with community members on Anderson Island who demanded that plans by DNR to lease an intertidal geoduck site in a pristine shoreline area be withdrawn. After several community meetings, DNR withdrew the plans. The same work was done with members of Harstine Island to stop the site located next to a pristine park.
- After many years of neighbor conflict with Taylor Shellfish, we provided the State Auditor's office documentation of the Taylor Shellfish illegal use of over 30 acres of public tidelands. The State of Washington finalized an agreement in 2008 where DNR will receive \$1,500,000 from Taylor to settle the trespass.
- The Shoreline Master Program update draft regulations are being developed and we are providing input and consulting with environmental attorneys to ensure that this update requires environmental and social protections as originally written and that scientific assessments are required prior to further aquaculture expansion.
- We are working on placing Olympia oysters for restoration in those areas that are conducive to their growth and where they will add ecological function.